

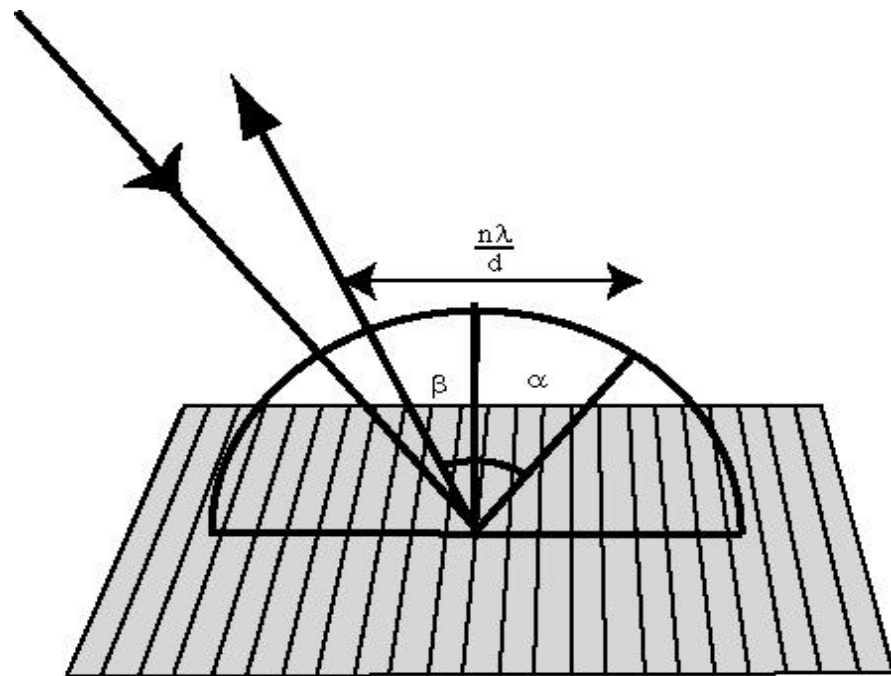
The Off-Plane Option for the Reflection Grating Spectrometer

Randy McEntaffer
Webster Cash, Steve Osterman,
Ann Shipley, Brian Gleeson

University of Colorado

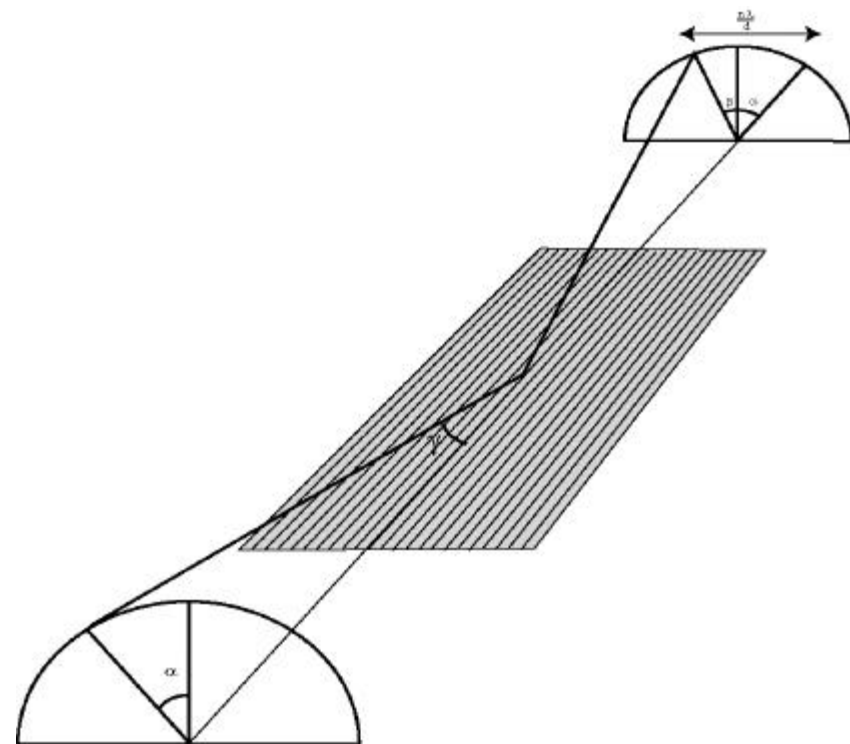
In-plane Mount

$$\sin \mathbf{a} + \sin \mathbf{b} = \frac{n\mathbf{l}}{d}$$

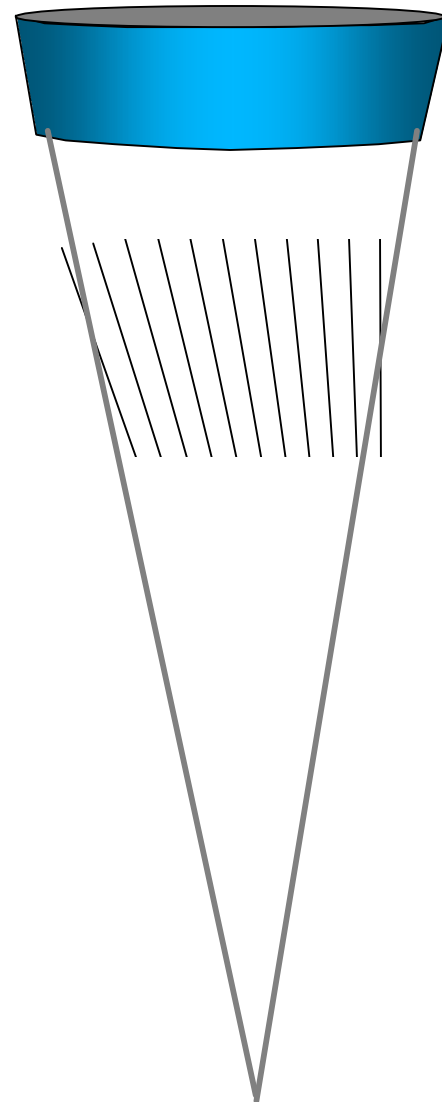
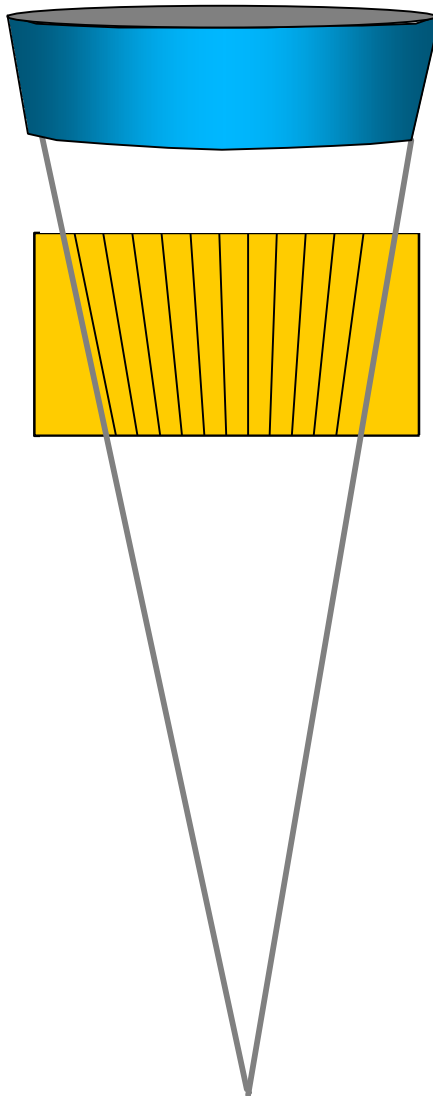
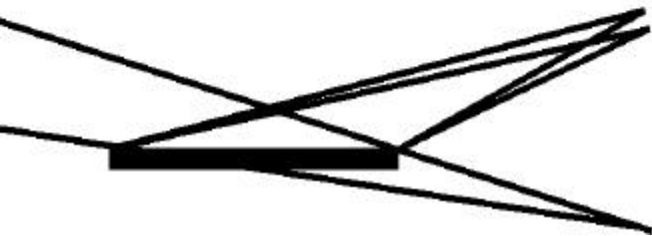
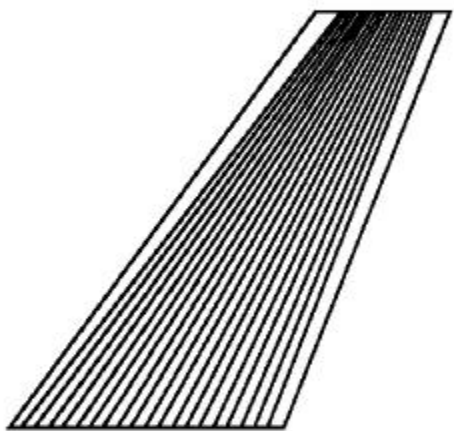


Off-plane Mount

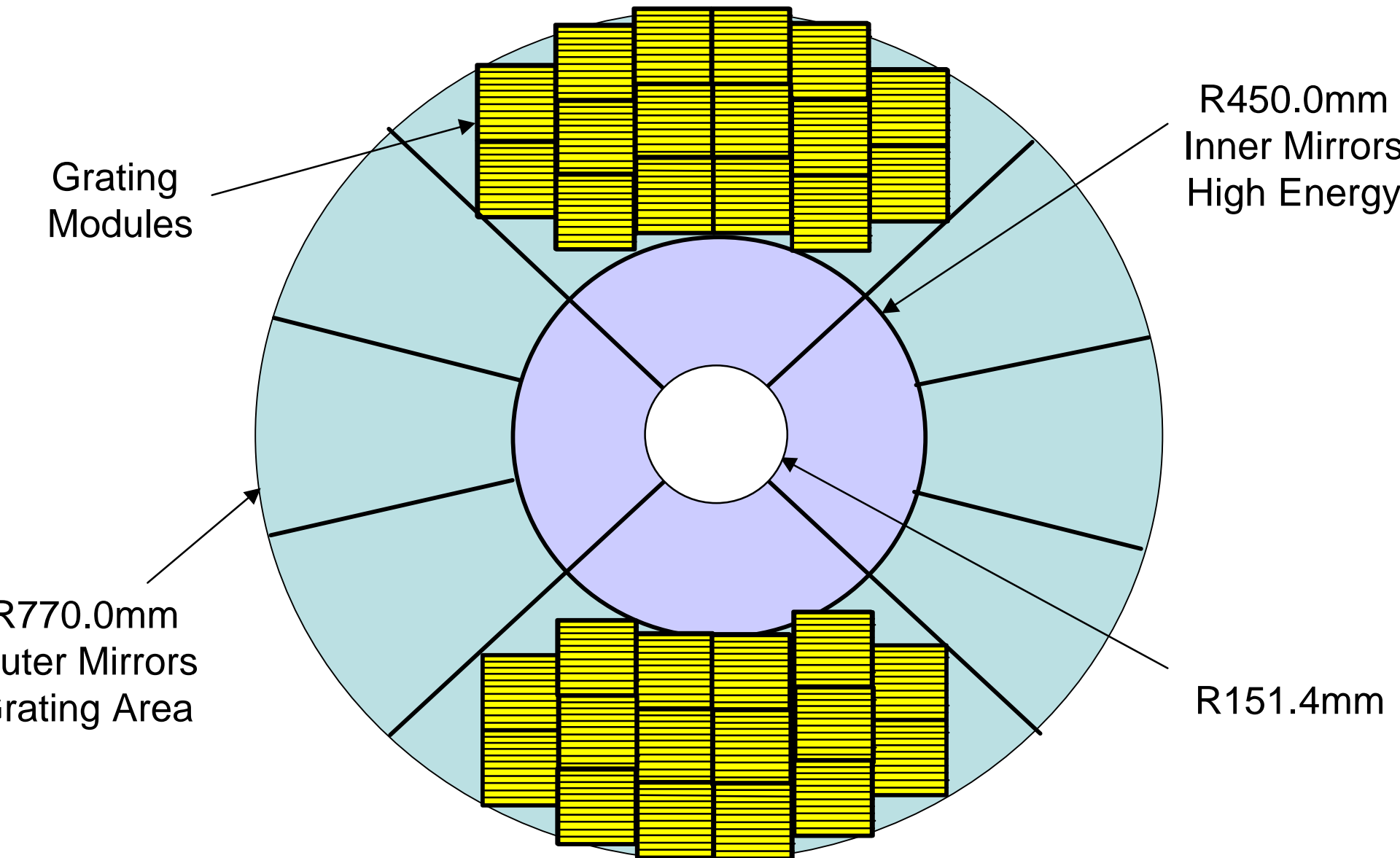
$$\sin \mathbf{a} + \sin \mathbf{b} = \frac{n\mathbf{l}}{d \sin \mathbf{g}}$$



Radial Groove Gratings



Off-plane Grating Module Locations on Envelope



Off-plane Tradeoffs

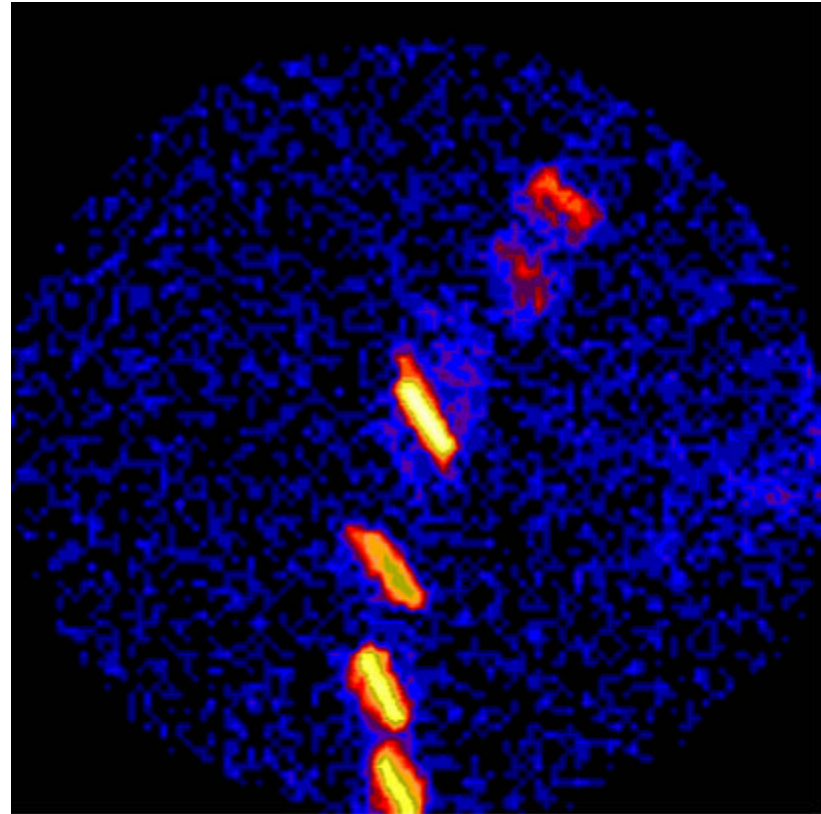
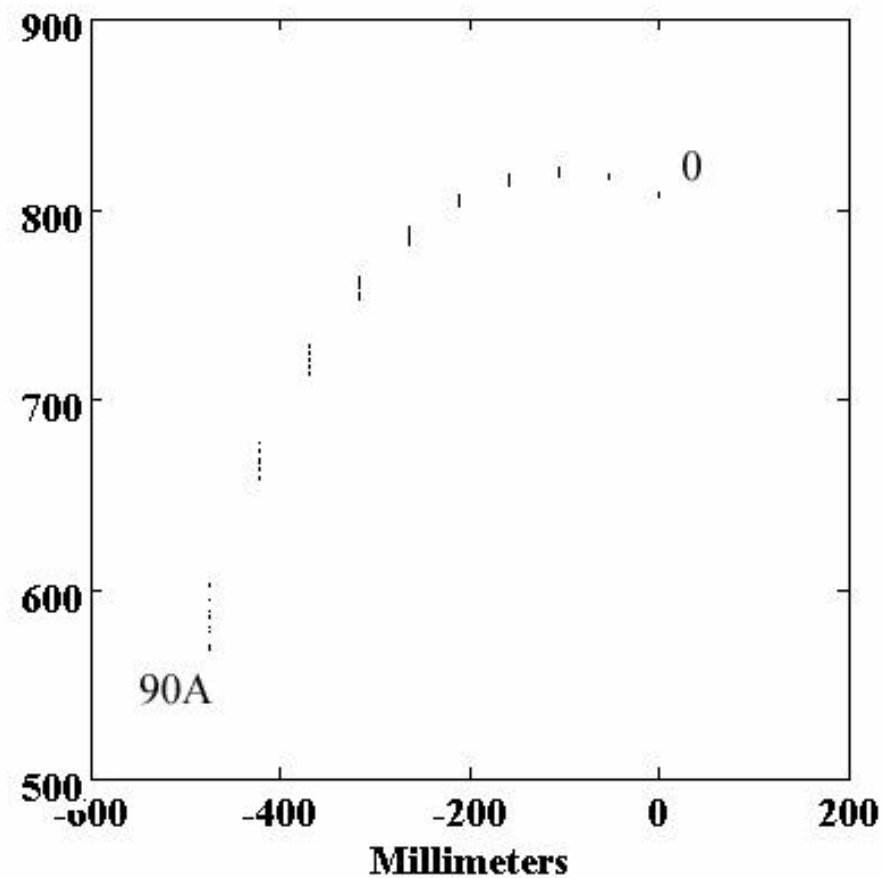
PRO

- Higher Throughput
- Higher Resolution
- Better Packing Geometry
- Looser Alignment Tolerances

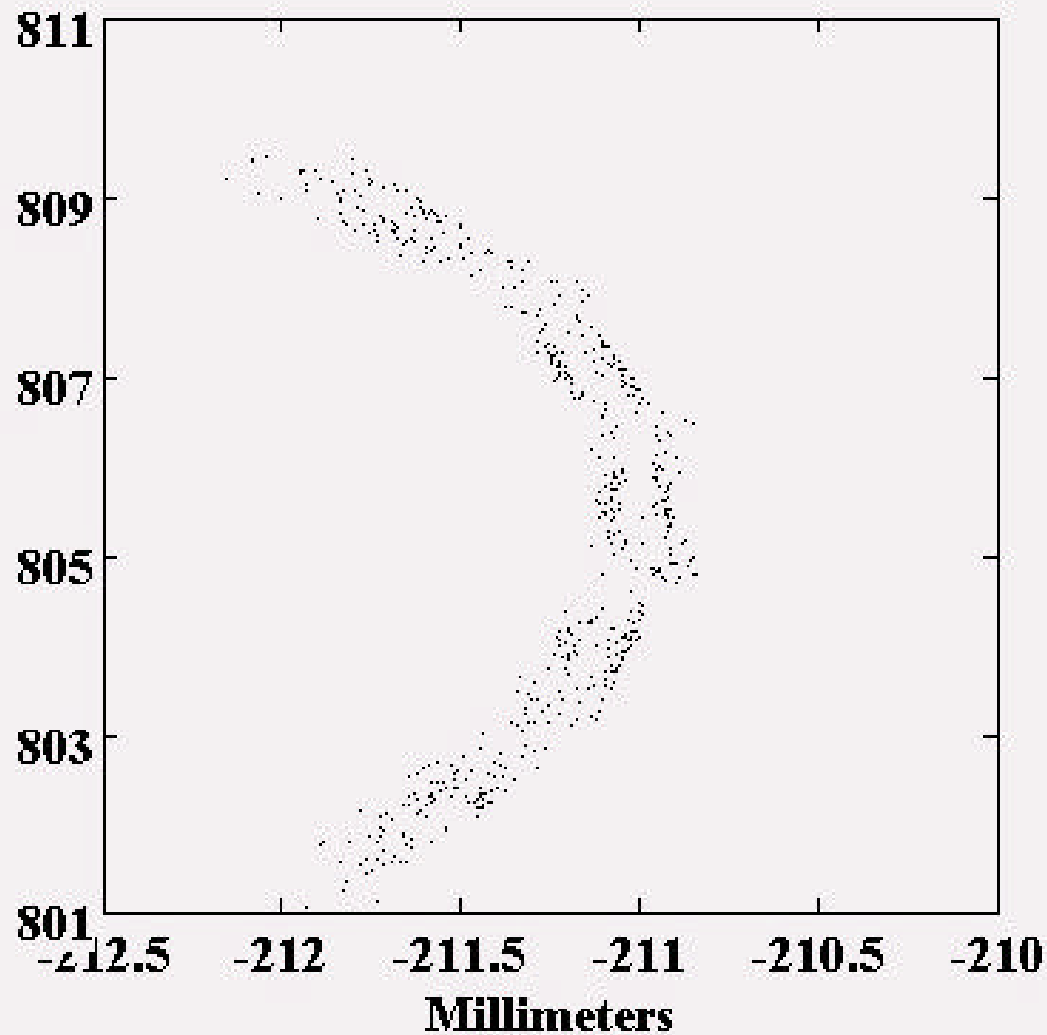
CON

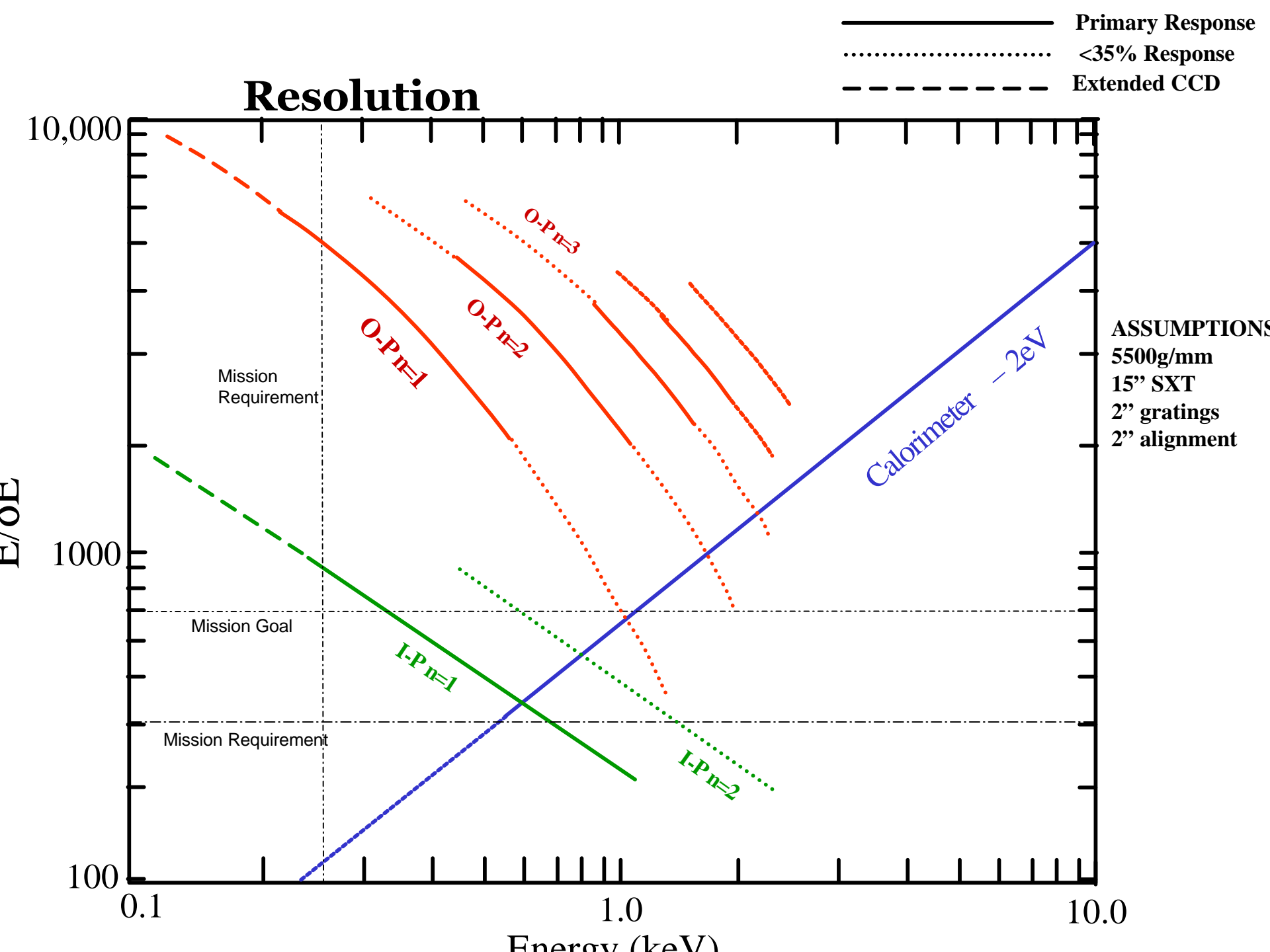
- Higher Groove Density

Raytracing – Arc of Diffraction

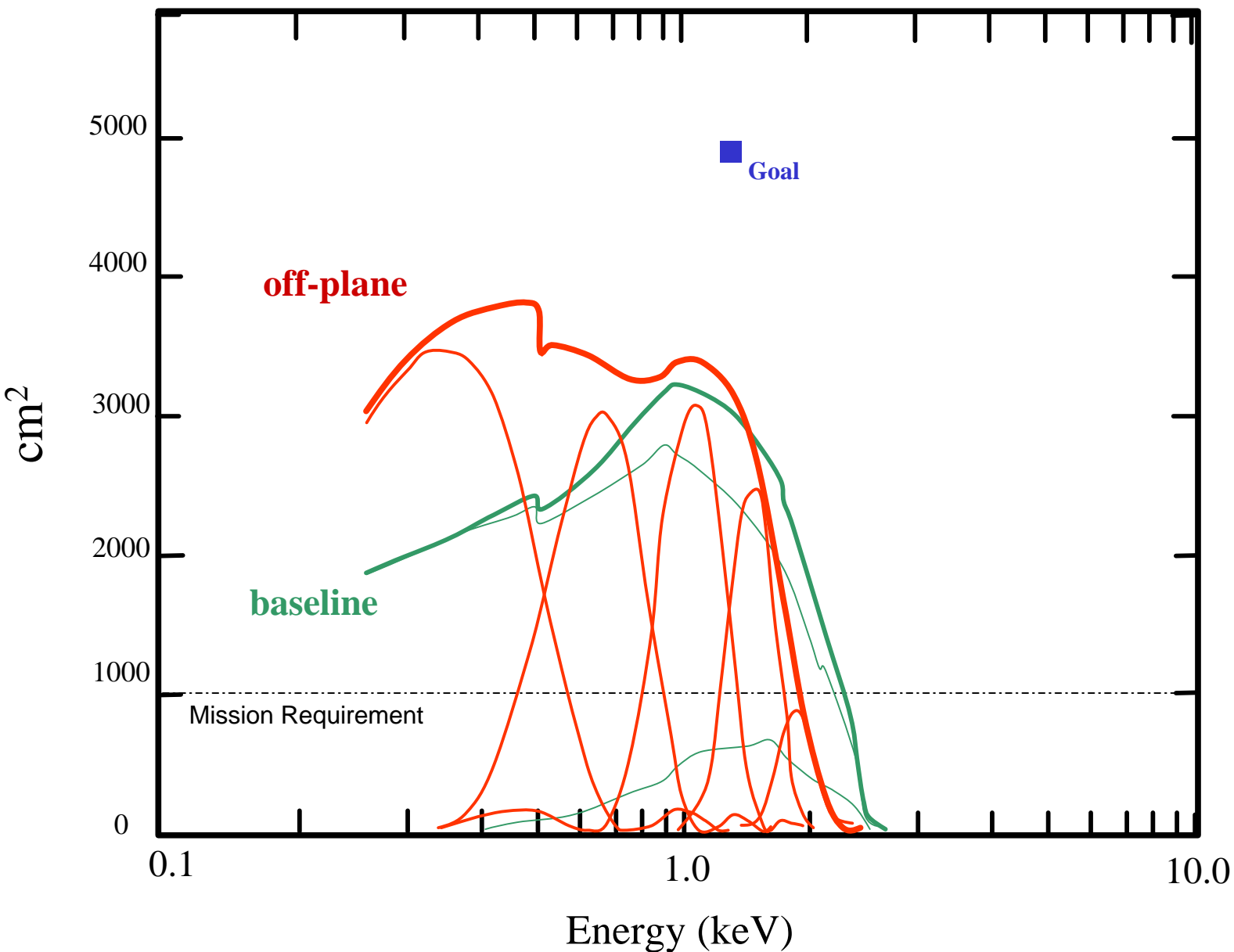


Raytrace – 35 & 35.028Å





Effective Area



ASSUMPTIONS:

Coverage 40% of
outer envelop

Off-Plane Groove
Efficiency 80%
of theoretical

85% Structure
Transmission

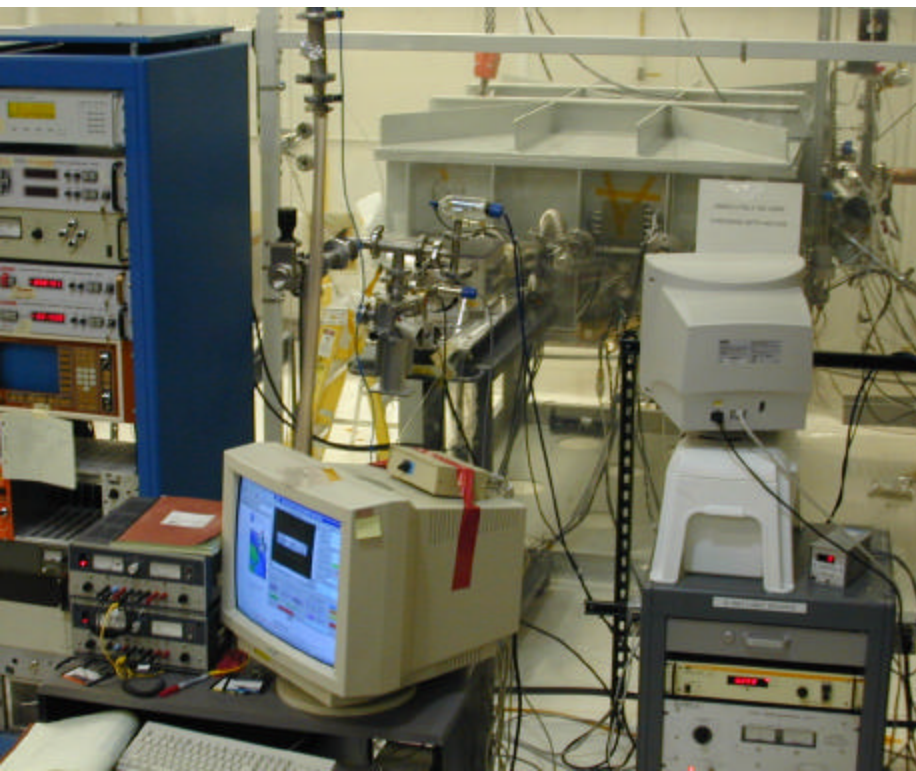
CCD thin Al filter
only

Off-Plane Program

- ? Optical Design – Projected Performance
 - Looks Attractive
- ? Engineering Requirements
 - Has Significant Advantages
- ? Grating Suppliers
 - Several Possible Suppliers
 - Holographic Techniques Look Better Than Mechanical
- ? Grating Efficiency
 - Test Gratings at Colorado Now
- ? Resolution Demonstration
 - Scheduled this Summer at Colorado
- ? TRL Development
 - Plan to Achieve TRL 6

Grating Test Facility at CU

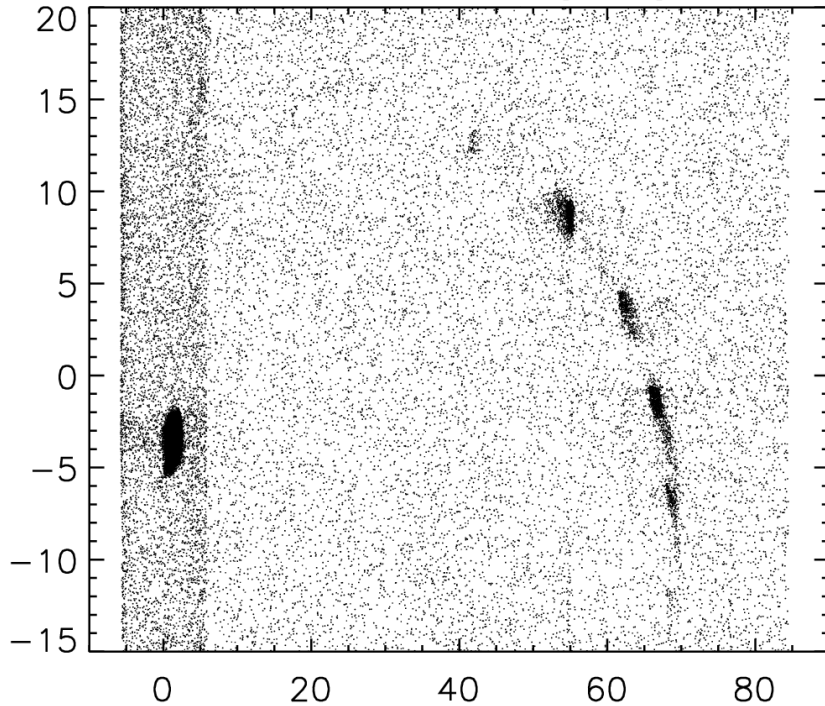
Used for COS and FUSE



Grating #1

- Jobin-Yvon, radial grooves, 4246 g/mm, unblazed

JY Step4 Sinusoidal Grating, Mg-K 1.25K ϵ



2.0 dea araze. 20030502 data set

@ $\theta = 2^\circ$ Absolute Efficiency:

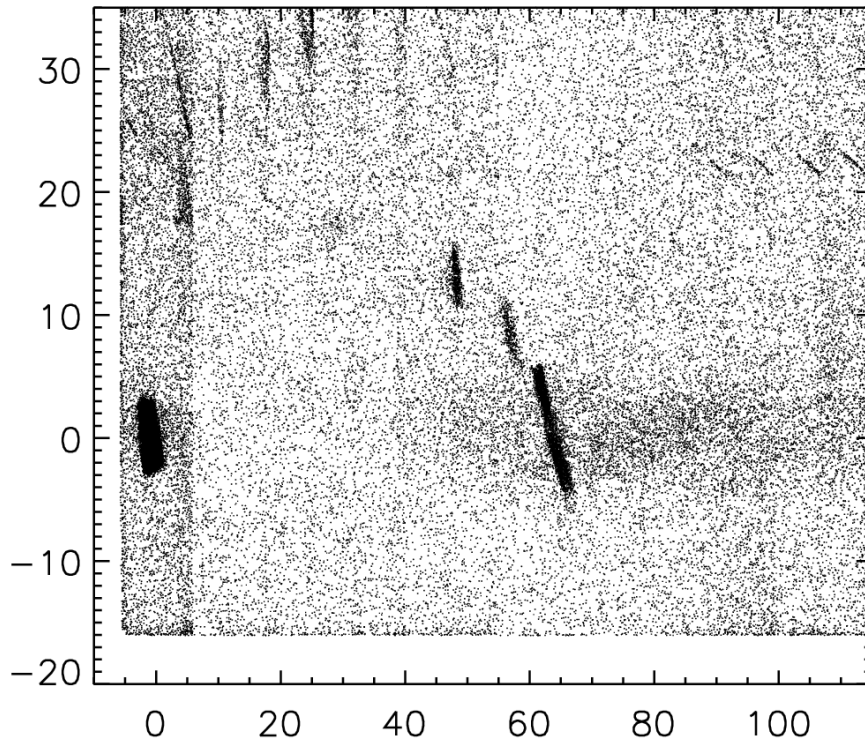
strongest order = 13%

Sum orders = 29%

Grating #2

- Jobin-Yvon, radial grooves, 4246 g/mm, blazed 13°

JY Step4 13 deg Grating, Mg-K 1.25KeV



2.0 dea araze. 20030428 data set

@ $\theta = 2^\circ$ Absolute Efficiency:

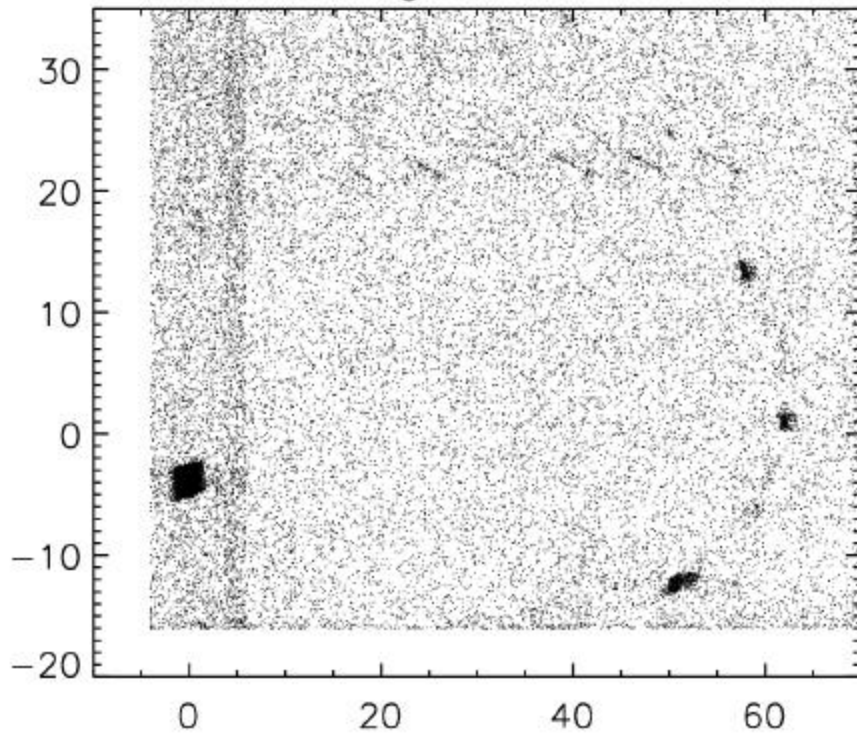
strongest order = 6.4%

Sum orders = 11%

30% (w/ scatter)

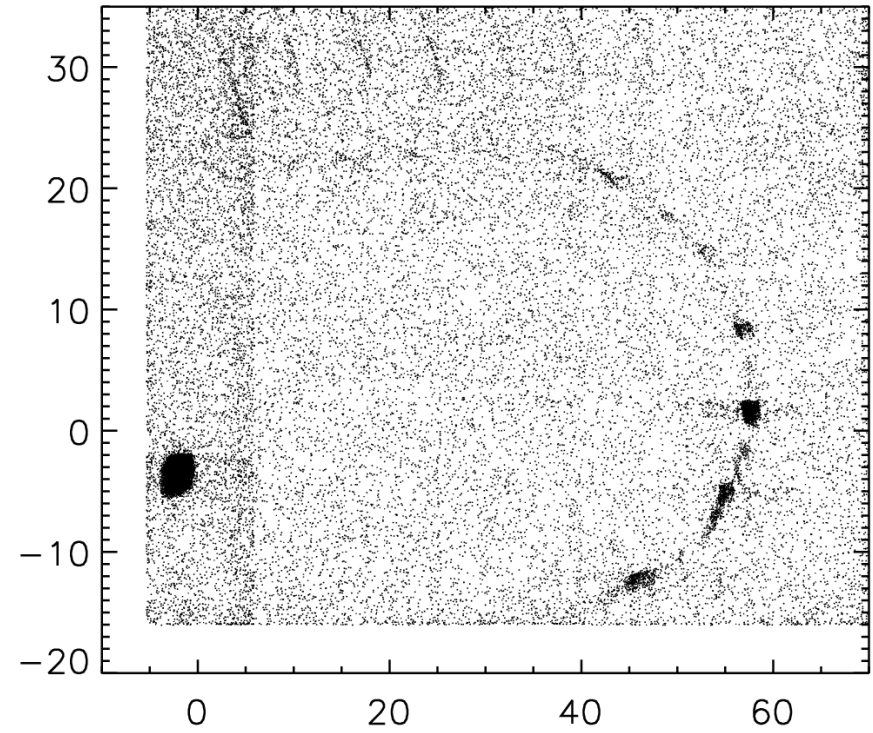
Grating #3

MIT Grating, Cu-L 0.93KeV



2.0 dea araze. 20030501 data set

MIT Grating, Mg-K 1.25KeV



2.0 dea araze. 20030501 data set

Grating #3

? MIT, parallel rulings, 5000 g/mm, blazed 7°

	?	Abs. Eff.	Abs. Eff.	Groove
	(degrees)	one order	Sum orders	Eff.*
Mg-K	1.35	25%	38%	54%
(1.25 keV)	1.5	28%	40%	59%
	2	9%	27%	48%
Cu-L	1.5	21%	24%**	35%**
(0.93 keV)	2	18%	30%	45%

Groove eff. = Abs. eff./Reflectivity (a.k.a. Relative eff.)

Conclusion

- ? Off-plane can significantly improve performance of Constellation-X RGS
- ? Gratings can be built to required efficiency and scatter specifications
- ? Resolution tests to be conducted this summer